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An Examination of the Differences Among Native Bilinguals, Late Bilinguals, and Monolinguals in Vocabulary Knowledge, Verbal Fluency, and Executive Control

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by

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An Examination of the Differences Among Native Bilinguals, Late Bilinguals, and Monolinguals in Vocabulary Knowledge, Verbal Fluency, and Executive Control

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The present study seeks to explore if the bilingual advantage and disadvantage of children who are natively bilingual in English and Spanish extends to children who gain exposure to and eventually become bilingual in these languages beginning at ages 5 and 6. Specifically, the study compares executive control, vocabulary, and verbal fluency for three groups of children: a) native Spanish-English bilinguals, b) late bilinguals that have completed at least 5 years of a 50-50 dual language immersion program in English and Spanish in school, and c) English monolinguals that have not had second language instruction. The proposed study seeks a better understanding of the unique cognitive skill sets of native and late bilingual and monolingual children, and to inform educational policy related to bilingual students.

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Chapter One: Introduction

The ability to speak more than one language is viewed as a coveted skill in the U.S., but there is little emphasis in public schools on teaching a second language or encouraging the maintenance of a second language. While most developed countries require students to take a second language beginning in elementary school, only about six percent of U.S. students study a foreign language in elementary school (American Council on the Teaching of Foreign Languages, 2006). When confronted with the challenge of educating students who enter the school system with limited proficiency in English, schools most commonly use a subtractive approach wherein the student's native language is replaced with English as quickly as possible (Linton, 2004). To understand fully the benefits and costs of bilingual education for native and nonnative speakers of English, more empirical research with sound methodology on the subject is needed (Cummins, 1999; Martinez, Bailey, Kerr, Huang, & Beauregard, 2010; Mora, Wink, & Wink, 2001). Further, when considering the academic and intellectual progress of students enrolled in bilingual programs, one must examine a wide range of outcomes due to the large number of variables involved in any given bilingual education program (Burry, 1982).

In addition to comparing standardized test scores or GPA for students who have participated in bilingual education programs and monolingual students (e.g., McNeil, Coppola, Radigan, & Vasquez Heilig, 2008), research should examine how the effort

involved in managing two languages, compared to one, may serve to help or hinder specific *cognitive* abilities of a child. The literature has not closely explained the impact of managing more than one language in one's daily life, especially in the context of participation in a bilingual education program. A better understanding of the influence of bilingualism on intellectual abilities in children may shed light on the unique abilities and needs of bilingual students[1], as well as inform bilingual educational policy.

The last 50 years of research examining the influence of speaking two languages on cognitive abilities has been controversial and polarized. Historically, the majority of research emphasized the negative consequences of bilingualism on cognitive abilities. It was thought that speaking two languages was a demanding and confusing task that could lead to severe developmental delays in children, including mental retardation (Bialystok & Craik, 2010). It was not until the 1960s that studies began to uncover advantages of speaking two languages fluently, such as enhanced executive functioning (Peal & Lambert, 1962). Over the last decade, studies have demonstrated superior abilities in bilingual children compared to their monolingual peers in areas of executive functioning, including the ability to control attention, inhibit distractions, and shift between tasks (Bialystok, 1999; Carlson & Meltzoff, 2008; Gollan, Montoya, & Werner, 2002;

[1] In the current study, *Bilingual* students refer to students who speak English and Spanish with equivalent proficiency, as measured by their performance on picture vocabulary tests in English and Spanish and a Language and Education Survey (see Method). *English Language Learners (ELLs)* refer to students who did not have English as their first language, whose home language is not English, and who do not yet have proficiency in English. The focus current study is on bilingual students rather than ELLs.

Bialystok, Craik, & Luk, 2008a, 2008b; Bialystok & Craik, 2010). At the same time, research continues to highlight the disadvantages in bilinguals compared to monolinguals in vocabulary size and verbal fluency.

The bilingual advantage in cognitive control has been shown in infants through older adults who are native bilinguals. One study demonstrated cognitive gains for infants who had been exposed to two languages since birth through eye-tracking tests, in which these infants were able to shift attention to a new location of a rewarding stimulus more quickly than infants who had only been exposed to one language since birth (Kovacs & Mehler, 2009). At the other end of the age spectrum, another study compared 93 bilingual and 91 monolingual older adults who had been diagnosed with dementia and with all else being equal, found that age of onset of dementia symptoms was four years later for bilingual adults compared to the monolingual adults in the study (Bialystok, Craik, & Freedman, 2007). Researchers have argued that using two languages regularly keeps the brain active, and slows cognitive decline.

Other studies on bilingualism have found smaller vocabularies and weaker and less efficient lexical access in bilingual individuals compared to monolinguals (Gollan et al., 2002; Bialystok et al., 2008a, 2008b; Sandoval, Gollan, Ferreira, & Salmon, 2010). These studies suggested possible mechanisms for the bilingual disadvantage in vocabulary, including the idea that the load of holding two linguistic representations of most items places a limitation on the number of lexical items a person can store in total (Sandoval et al., 2010). In describing a vocabulary deficit for bilinguals, the vast

majority of studies have examined vocabulary size in only one language, rather than looking at total vocabulary size in two languages for an individual. For verbal fluency, researchers have posited that bilingual individuals are less efficient in accessing lexical content due to the cross-language interference of needing to activate two representations when searching for a word in a given language (Sandoval et al., 2010; Gollan et al., 2002). Bialystok, Craik, & Luk (2008) suggest that the bilingual advantage in cognitive control and the bilingual disadvantage in lexical access are interdependent and exist in the same individuals. They propose a cross-language interference framework, suggesting that the lexical conflict created by activating representations of two different languages is resolved through the mechanism of attentional control of the frontal lobe, used in executive functioning (Bialystok, Craik, & Luk, 2008).

Though research has begun to expand our understanding of the specificity of and neural mechanisms behind cognitive differences in bilingual and monolingual children, many questions remain unanswered. While evidence has shown that *native* bilinguals have stronger skills on cognitive control tasks compared to monolinguals, studies have yet to explore if similarly enhanced abilities are found in children who acquire a second language *later* in life, such as through bilingual education programs in schools. The literature is unclear about whether executive control benefits of bilingualism are gained by children who begin to develop proficiency in a second language at 5 or 6 years of age, for example, and if lexical access may weaken as a result of becoming bilingual for this population.

The present study seeks to explore if the bilingual advantage and disadvantage of children who are natively bilingual in English and Spanish extends to children who gain exposure to and eventually become bilingual in these languages beginning at ages 5 and 6. Specifically, the study compares executive control, vocabulary, and verbal fluency for three groups of children: a) native Spanish-English bilinguals, b) late bilinguals that have completed at least 5 years of a 50-50 dual language immersion program in English and Spanish in school, and c) English monolinguals that have not had second language instruction. The proposed study seeks a better understanding of the unique cognitive skill sets of native and late bilingual and monolingual children, and to inform educational policy related to bilingual students.

Chapter Two: Integrative Analysis

Bilingualism and Education in the U.S.

Approximately twenty percent of individuals living in the U.S. speak two or more languages fluently (U.S. Census Bureau, 2003). The incorporation of non-English languages into public institutional contexts, including schools and government, has been a challenging issue over centuries and continues to pose a dilemma for policy makers at the state and federal levels (Linton, 2004). Models of immigrant assimilation have historically encouraged individuals to lose the characteristics of their homeland, including their home language, and adopt English as their primary language. More recent models, on the other hand, emphasize that new U.S. residents should have the opportunity to become proficient in English *and* maintain proficiency in their native language(s) (English Plus, 2000). In terms of educational contexts, there is neither strong support for the preservation of students' native languages in most U.S. schools, nor recognition of unique cognitive abilities of bilingual compared to monolingual students.

There is a limited consideration in schools about how a student's exposure to a second language, including the age of exposure, may influence his or her abilities in both their native and second language. Instruction and assessment of students may vary in effectiveness and accuracy based on factors surrounding language, such as exposure to two or more languages, and the need to switch between two or more languages in daily life (Dworin, 2003; Bialystok, 1999). New research about the differences in cognitive

abilities of bilingual compared to monolingual students will provide implications for instructional and assessment strategies for bilingual students.

Public schools are at the forefront of the challenge in how to effectively and appropriately educate children who enter the system with a need to gain proficiency in English, or with a desire to maintain proficiency in a non-English language. Students who speak English as a second language have historically been underserved in U.S. public schools (Thomas & Collier, 1997; 2002). In the early 20th century, schools operated under English-only mandates that discouraged the use of non-English languages in classrooms (Blanton, 2004). It was not until the passage of the Bilingual Education Act in 1968 that the federal government recognized the need for improved and differentiated educational services for students with limited English proficiency.

At present, classroom models for ELLs, and for students who wish to maintain or attain bilingual capacities, are highly diverse. Bilingual programs, and dual-language programs specifically, have been demonstrated to be superior to English as a Second Language (ESL) programs in their effectiveness in closing the achievement gap between ELL students and native English speaking, monolingual, peers (Thomas & Collier, 1997; 2002). Research shows support for models of educating ELLs that involve substantial instruction in both a student's native language and English and a more gradual transition to full English immersion. These programs tend to support the maintenance of both languages and foster a sense of multiculturalism in the classroom (Thomas & Collier,

1997; 2002). Specifically, two-way bilingual immersion programs (TWBI), which are beginning to be implemented in elementary schools with high percentages of ELLs, have been shown to be highly effective in educating their students in two languages. TWBI programs have an equal number of native English speakers, who are often monolingual to begin with, and native speakers of other languages, who have varying proficiency in each language (http://www.twowaycabe.org). These programs vary in the amount of instruction time spent in each language. In 50-50 TWBI programs, for example, 50% of the instruction time is spent in English and 50% of the time is spent in another language, and in 90-10 TWBI programs, 90% of instruction time is in English, with 10% of instruction time in another language. The most optimal ratio for students to gain proficiency in two languages has been shown to be in the 50-50 TWBI model (Thomas & Collier, 1997; 2002).

The ultimate goal of TWBI programs is for students to become proficient in two languages, while also reaching high content area standards for achievement. Research has shown that to provide adequate means for students to achieve proficiency in English and another language, as well as to reach achievement standards on standardized tests that are predominantly in English, students should participate in the programs for 5-7 years (Tsang, Katz, & Stack, 2008). It is also suggested that there should be some separation of languages with regards to instruction time (Thomas & Collier, 1997; 2002). TWBI programs tend to be successful in incorporating students with a wide variety of

language experiences (http://www.twowaycabe.org), and this fits with the reality that students entering U.S. schools have highly varied language backgrounds.

A unique facet of TWBI programs is that they include English Language Learners, or *emerging* native bilinguals, and students who are monolingual in English. Parents of native bilingual children who have been exposed to both English and Spanish from birth might wonder how a program that seeks to continue to foster development of both languages in their child will impact their child's learning in one or both languages. And when parents consider enrolling their English monolingual child in a TWBI bilingual program, they will also likely be curious about the efficacy and benefits of bilingual education for their child's abilities in both languages. Parents of monolingual children might also question how the child's age might impact his or her ability to acquire a second language, and how the age at which their child is exposed to a second language may influence his or her ability to become proficient in the new language, and to manage a native language and a second language.

Critical Period for Language Development

It is widely accepted that the process of language acquisition is subject to age constraints, a perspective supported by Lennenberg's (1967) critical period hypothesis for language development. The critical period hypothesis asserts that from around the first year of a child's life through early adolescence, the brain is best suited for language acquisition and one has much greater difficulty acquiring a language after this period.

According to the critical period hypothesis, children can effortlessly gain proficiency in a language during their first few years of life as long as they are exposed to a linguistically rich environment. Lennenberg's (1967) work was largely based on pathological studies that showed high rates of recovery in language abilities in children with left hemisphere damage compared to much lower rates of recovery in adults, suggesting a lack of plasticity in brain organization after early adolescence. While the critical period hypothesis for first language acquisition is well established, it is less clear how the critical period is relevant to *second* language acquisition.

Research in developmental psychology, neuropsychology, and linguistics has begun to explore the critical period hypothesis in the context of second language acquisition. Studies across disciplines have revealed some evidence that amount of exposure to and proficiency in a second language, rather than age of acquisition, is the key factor in learning the new language (Hakuta, Bialystok, & Wiley, 2003; Perani, et al., 1998). Findings converge across a variety of studies, including secondary data analysis and neurological studies, about the lack of a clear cut-off age in developing fluency in a second language. In an analysis of the 1990 U.S. Census data, researchers examined age of immigration to the U.S. and second-language attainment (Hakuta et al., 2003). Using the ages 15 and 20 (i.e., mid and late adolescence) as hypothesized cutoff points for end of the critical period, the researchers found that there was no clear discontinuity in second language acquisition after these ages. Instead, they found that the degree of success in attaining a second language steadily declined throughout the lifespan. The authors

suggested that socio-educational variables, such as opportunities for formal education, and cognitive aging factors, such as decreased working memory capacity and processing speed, influenced the learning of a second language (Hakuta et al., 2003).

Brain imaging studies have also demonstrated support for a gradual, linear relationship between age of second language acquisition and performance on language tasks. This is incongruent with the critical period hypothesis, which predicts a clear drop-off in second language acquisition at a certain age. Bloch et al. (2008) found that early exposure to more than one language was linked to more homogenous cortical activation when using the learned languages, while later exposure was linked to more heterogeneous cortical activation that depended on which of the learned languages was being used. The authors found that the change in uniformity of cortical activation of multilingual participants in their study was *gradual* with age, and there was no age point of discontinuity. The finding that brain activation varied gradually with age provides evidence against a critical time period for native-like representation of later learned languages.

Brain imaging studies have also suggested that level of proficiency in a second language, rather than age of acquisition, determines the cortical representation of the second language in auditory processing (Perani et al., 1998). In one study, researchers used Positron emission tomography (PET) to examine differences in brain activation in auditory processing of a subject's native language (L1) compared to their second

language (L2). The researchers examined bilinguals who had learned their L2 either before the age of 4 (early acquisition) or after the age of 10 (late acquisition), and bilinguals who had either high or low proficiency in the L2. They determined that differences in activation of brain regions when processing L1 and L2 were based on level of proficiency rather than age of acquisition, such that L1 and L2 activated the same cortical areas when proficiency in the L2 was high (Perani et al., 1998). This finding demonstrates the plasticity of the network that mediates language comprehension in the bilingual brain, and shows that when proficiency of L2 is held constant, age of acquisition does not appear to have an impact on cortical representations of the L2. This provides further neurological basis for support against the critical period hypothesis as it relates to second language acquisition because it shows how brain activation in auditory processing of languages depends on mastery of an L2 rather than age of learning an L2.

Another study supporting linguistic plasticity in second language acquisition showed that adults who acquired a native language early in life, both hearing adults who used speech and deaf adults who used signing, were able to acquire native-like proficiency in a second language later in life (Mayberry & Lock, 2003). In comparison, deaf adults who were not exposed to any language (symbolic or spoken) early in life performed poorly in later acquisition of a second language. The authors interpreted these findings to convey that early language acquisition, through early linguistic stimulation from the environment, is critical for the development of syntactic representations that promote later language learning. The authors suggested that age does not equally

constrain the acquisition of a first and second language, but rather acquiring a first language early in development impacts one's ability to learn a second language later in life. This finding lends support for a revised form of Lennenberg's (1967) critical period hypothesis for second language acquisition in which the early establishment of a complex language system is the key factor in the ability to learn a language later in life, regardless of age of second language acquisition (Mayberry & Lock, 2003).

The proposed study hypothesizes that because all participants will have been exposed to language early in life, regardless of the number of languages they were exposed to, they will able to acquire proficiency in a second language later in life. The proficiency with which younger and older children are able acquire a second language has implications for education, in both instruction and assessment. Numerous studies have uncovered differences in the cognitive strengths and weaknesses for bilingual compared to monolingual individuals based on the unique demands of managing two compared to one language (e.g., Bialystok, 1999). It is important to investigate if these cognitive differences appear to apply to native bilinguals exclusively, or if they also apply to individuals who are exposed to more than one language regularly beginning at a later age. In addition, understanding the cognitive outcomes of bilingualism for both native and nonnative bilinguals, and clarifying how these outcomes differ for the groups, will help to inform classroom models that aim to support students in preserving or acquiring bilingualism. The following sections review the historical and current literature on the impact that bilingualism has shown to have on cognitive abilities.

Historical Perspectives on Bilingualism and Cognitive Abilities

Historically, studies have speculated about the detrimental effects of bilingualism on children's cognitive abilities. It was warned that the burden of managing two languages could impede children's normal development (for reviews see Bialystok, 2001; Hakuta & Diaz, 1985). Many of these studies from the 1920s through 1950s were methodological flawed, and the majority did not control for socio-economic disparities between the monolingual and bilingual groups. Bilingualism in the U.S. was significantly confounded with socioeconomic status during the 1930s through 1960s, as is also common at the present time (Cummins, 1999). Early research reported that more than half of bilingual school children could be classified as belonging to families from unskilled labor occupational groups (Blanton, 2004). Nevertheless, consistent published findings about bilinguals' linguistic deficiencies led to widespread acceptance about the negative effects of bilingualism, and it was not until 1962 that these findings were called into question. In their landmark study, Peal & Lambert (1962) studied 10-year-old monolingual and bilingual children from the same school system in Montreal, who were pre-screened on proficiency and cognitive measures. The authors found that when group differences in sex, age, and socioeconomic status were appropriately controlled, bilingual children performed significantly higher than monolingual children on a variety of verbal and nonverbal abilities. In general, bilinguals were found to have a more diversified set of abilities compared to their monolingual peers, and bilinguals showed particular strength on tasks of cognitive flexibility (Peal & Lambert, 1962).

Since 1962, literature has provided support for the advantages and disadvantages of bilingualism in children's cognitive abilities, and current research supports the advantage in cognitive flexibility and control for bilinguals and disadvantage in verbal fluency and vocabulary size for bilinguals compared to monolinguals (e.g., Bialystok, 1999; Carlson & Meltzoff, 2008; Bialystok & Craik, 2010). The following sections review the current literature on the following areas of differences between bilinguals and monolinguals: verbal fluency, vocabulary size, and executive control. Verbal fluency and vocabulary size are associated with efficiency and strength of verbal abilities, while executive control is implied in areas such as planning, mental flexibility, and adapting to new situations.

Differences in these areas across native bilingual, late bilingual, and monolingual children have implications for instruction and assessment of these groups in the school setting. The main focus of this study is to determine the possible existence of differences in these cognitive abilities across language groups, rather than focusing on the relationships between these abilities.

Bilingual Advantages and Disadvantages

Verbal fluency is a common neuropsychological test that measures how quickly and automatically one can retrieve and produce vocabulary words. High verbal fluency reflects efficient organization of vocabulary, while low verbal fluency suggests less efficient access to words (Baron, 2004). Included in the verbal fluency measure are letter

fluency, which tests the ability to name words based on a letter cue (e.g., words beginning with the letter *F*) and semantic fluency, which tests the ability to name words based on a semantic cue (e.g., *animals*). The verbal fluency task taps into two cognitive abilities: a) linguistic abilities based on left hemisphere functioning, such as vocabulary size, and b) cognitive control based on frontal lobe functioning, such as the ability to inhibit prepotent responses, or rule-breaking. Although the verbal fluency task is a highly common test in neuropsychological evaluations, prior studies have not reached conclusive findings about how bilingualism affects performance on the task (Gollan et al., 2002). Examining how bilinguals perform on the task may shed light on the clinical utility of the task for bilinguals, especially since it is such a common test in neuropsychological assessment batteries, and increase our understanding about the cognitive demands of the task.

Studies have found that bilinguals produce fewer words than monolinguals within the given 60-second time limit on tasks measuring verbal fluency (Gollan et al., 2002; Bialystok et al., 2008a; Sandoval et al., 2010). In a study comparing Spanish-English bilinguals on three verbal fluency categories, including semantic, letter, and proper-name categories, bilinguals produced fewer correct responses than monolinguals across categories (Gollan et al., 2002). This study was novel in that it included a manipulation for half of the trials for bilingual participants, in which they were instructed that they could complete the tasks using words either in Spanish or English, and would get credit for a word in either language that matched task requirements. The authors found that

monolinguals performed better than bilinguals even on the trials that allowed bilinguals to use both languages, and this was suspected to be due to the cost of spontaneous language switching on processing speed for bilinguals (Gollan et al., 2002).

Sandoval et al. (2010) compared bilinguals and monolinguals on letter and semantic fluency tasks by examining the time-course for retrieval for both groups, and looked at performance in the dominant language compared to non-dominant language for the bilingual group. The authors found that bilinguals made fewer correct responses, had slower first response times, and showed delayed retrieval compared to monolinguals, and this pattern was found when bilinguals used their dominant and non-dominant languages (Sandoval et al., 2010). A particularly novel finding of the study was that bilinguals actually produced more low-frequency words, or words that are less common in daily use, than monolinguals. As there are often fewer representations across languages for low-frequency compared to high-frequency words, this finding suggests that competition between languages, or *cross-language interference*, plays a role in the verbal fluency disadvantage for bilinguals.

Disadvantages in verbal fluency for bilingual compared to monolingual individuals have been shown across ages, indicating that deficits in verbal fluency are not easy to overcome with practice of switching between two languages or greater experience as a bilingual. Bialystok et al. (2008a) compared cognitive abilities of 96 participants, who were in categories of younger (M = 20 years) or older (M = 68 years) and

monolingual or bilingual. For the effect of language group, the authors found that monolinguals performed better than bilinguals on verbal fluency tasks used, including the letter and semantic fluency tests, across ages. Another study demonstrated that vocabulary knowledge contributed to the performance on verbal fluency measures for bilinguals and monolinguals. Luo, Luk, & Bialystok (2010) compared two groups of bilinguals – a high-vocabulary and low-vocabulary group based on performance on a receptive vocabulary measure – and a group of monolinguals on category and letter fluency tasks. The authors aimed to disassociate the advantageous effects of executive control for bilinguals from differences in vocabulary. They found that the bilingual and monolingual groups performed similarly on the category fluency task, but the high-vocabulary group outperformed both groups on the letter fluency task, suggesting that controlling for vocabulary allowed the executive control advantages for this group to be observed (Luo, Luk, & Bialystok, 2010).

Vocabulary is critical for comprehension of written and spoken language, is strongly related to reading comprehension, and is often used as an indicator of general verbal abilities. Vocabulary knowledge influences a child's performance across a variety of domains and can serve to bolster or hinder achievement across subject areas. Vocabulary size is often measured through picture-naming tests, such as the Woodcock Picture Vocabulary test, which assesses children's vocabulary knowledge in English and Spanish (Woodcock, 1991; Woodcock & Muñoz-Sandoval, 1995). The process of measuring vocabulary, and assessing its implications, becomes highly complex when

considering bilingual children because words can be known to different degrees in either language. The relation between Spanish and English vocabularies has only been explored recently in the research, and findings are inconclusive (Branum-Martin, et al., 2008; Proctor, August, Carlo, & Snow, 2006). There remains a great need to increase understanding of how and why bilinguals and monolinguals might differ in vocabulary size.

Research has shown a disadvantage for bilingual compared to monolingual participants on measures of receptive vocabulary (e.g., Bialystok et al., 2008b; Oller, et al., 2007; Gollan, Montoya, Fennema-Notestine, & Morris, 2005), and there are inconclusive findings as to the mechanisms behind this disadvantage. It has been suggested that even when bilinguals demonstrate similar abilities to monolinguals on some verbal tasks, such as basic reading tasks, the same bilinguals tend to show lower vocabulary size than monolinguals (Oller et al., 2007). In one study, researchers re-analyzed data from a broad scale study comparing English monolingual and Spanish-English bilingual 1st graders in Miami with the goal of discovering commonalities and differences across the two groups (Oller & Eilers, 2002a, 2002b). The researchers found comparable abilities across groups in some language domains, such as phonics, but consistently found lower vocabulary sizes in both languages for the bilingual compared to the monolingual students. An explanation of the result is the "distributed characteristic" of bilingual vocabulary knowledge, which refers to the tendency of bilingual children to know translation equivalents of some vocabulary words but not others. The distributed

characteristic presumes that bilingual children are exposed to their two languages across different sets of circumstances, and therefore their experience with words in each language is unevenly distributed. For example, a bilingual student may be exposed to more academic vocabulary in English in school and more daily living vocabulary in Spanish at home. Vocabulary tends to be more affected by this uneven distribution of experience than other aspects of language, such as phonics, because the learning essentials of phonics are necessary in any circumstance requiring reading (Oller et al., 2007).

Verhoeven (1994, 2000) compared monolingual Dutch children with bilingual Turkish, Moroccan, and Caribbean elementary school aged children in the Netherlands on several academic and language domains. The native, monolingual Dutch children were found to have a significantly larger lexicon than the bilingual children in Dutch, while both groups showed similar phonological, literacy, and pragmatic skills. In areas such as reading comprehension, the monolingual Dutch children showed significant advantage over the bilingual children, and it was found that lower vocabulary knowledge contributed to lower reading comprehension for the bilingual children more than for the monolingual children (Verhoeven, 2000). Unlike some other aspects of language, vocabulary is context-specific and this limits the amount of practice bilinguals have using words in different settings. Verhoeven's (1994, 2000) research suggests that helping to build the lexical knowledge of bilingual children in their second language is necessary for increasing their academic performance in other areas, such as reading comprehension. A

first step would be acknowledging this disadvantage in vocabulary size for a single language in bilingual students in the school setting.

The literature suggests that bilinguals have smaller vocabularies in both their dominant and non-dominant languages than bilinguals. These studies have found that bilinguals tend to have more limited vocabularies than monolinguals even when they perform the picturing-naming vocabulary task in their dominant language (Gollan et al., 2005; Ivanova & Costa, 2008). Gollan et al. (2005) compared the abilities of monolinguals and bilinguals on a picture-naming task, with all of the bilingual students in the study having reported that English was their best language or that they had equal abilities in both languages. The authors found that, even for bilinguals who reported English as their strongest language, bilinguals named pictures more slowly and with more errors than their monolingual counterparts. Interestingly, on a picture-classification task that required these same groups to classify a picture as being either human-made or natural, bilinguals performed as well as monolinguals. This suggests that bilinguals are able to determine the *meaning* of a word as quickly as monolinguals, but need more time to retrieve the name of the word in the appropriate language. The bilingual disadvantage in vocabulary size appears to be affected by the processing cost of retrieving the language-specific word after being exposed to the picture, which supports the idea that bilinguals have a single store of semantic information, accessed by both languages. Vocabulary size in bilinguals has been shown to be lower than in monolinguals due to

less frequent exposure to words in both languages and due to the processing cost of searching for a word in the appropriate language.

There remains the question of whether the processing cost for bilinguals is ameliorated by allowing bilinguals to name pictures in either languages when performing the picture-naming task. In one study, researchers compared performance on a Spanish language picture-naming task for a group of Spanish monolinguals, a group of Spanish-Catalan bilinguals whose dominant language was their L1 (Spanish), and a group of Catalan-Spanish bilinguals whose non-dominant language was their L2 (Spanish) (Ivanova and Costa, 2008). The researchers found that monolinguals outperformed both groups of bilinguals on the picture-naming task, both when bilinguals were given the task in their L2 and, more interestingly, when they were given the task in their L1. They found that the bilingual disadvantage for accessing vocabulary did not disappear after repeated trials, and that the disadvantage was larger for low- compared to high-frequency words. The researchers suggest that this disadvantage arises because bilinguals need more time to retrieve words from their L1 (and L2) lexicons because they do not use these words as frequently as monolingual speakers. This makes sense when one considers that even the L1-dominant bilinguals in the study reported using their L1 only 73% of the time, compared to the monolinguals in the study who reported using their L1

97.5% of the time[2] (Ivanova & Costa, 2008). Even for bilinguals who report using their dominant language three-quarters of the time, there is less time overall being exposed to the dominant language compared to monolinguals. The implications of these findings are harder to decipher, however. While bilinguals may tend to have smaller vocabularies in each language individually compared to monolinguals, the total sum of a bilinguals' vocabulary, when factoring in the total number of words in both languages, will invariably be larger than a monolinguals' vocabulary.

As assessments in school in the U.S. predominantly examine vocabulary size in English as a measure of intelligence and achievement, it would be worthwhile to understand how holding a lexicon in second language might affect performance on these assessments.

Executive control describes the ability to selectively attend to stimuli, especially in misleading or conflicting situations, and to be cognitively flexible or able to shift gears across situations (Bialystok, 1999). These abilities are commonly described as higher order skills, which draw upon and integrate more basic abilities, such as perception, memory, and motor skills (Baron, 2004). Executive control requires self-control of motivation and attention, cognitive flexibility, internalization of self-directed speech for planning, and it taps into working memory. Individuals who have strong executive

[2] The difference between the L1 and L2 language use percentages was statistically significant ($t(72) = 7.16$, $p < .001$).

control skills tend to be highly competent in adapting to new environments, flexibly changing direction in tasks, and responding in an integrated manner (Baron, 2004). Data consistently indicate that the frontal lobe of the brain is implied in executive control (Mega & Cummings, 1994). Frontal lobe development is ongoing throughout childhood, and executive control has been found to depend on the prefrontal cortex and the interaction of the prefrontal cortex with other brain regions in children (Baron, 2004).

Numerous studies have demonstrated an advantage for bilingual compared to monolingual individuals in executive control (e.g., Bialystok, 1999, Carlson & Meltzoff, 2008). It has been argued that enhanced executive control in bilinguals is the result of their increased demand, compared to monolinguals, in managing and switching between two languages, and inhibiting one language depending on the context. In one study, Bialystok (1999) compared Chinese-English bilingual and English monolingual children on their performance on two tasks that required the children to resist attending to a salient aspect of the problem and focusing on another aspect. The two tasks used, the moving word and dimensional card sort tasks, tap into attention control and inhibition of a distracting response. The bilingual children demonstrated more advanced abilities than monolinguals on both tasks. A novel contribution of this study, compared to previous research, was the finding that the bilingual advantage was demonstrated in a nonverbal task (dimensional card sort), which appears to have no connection to linguistic abilities.

Studies have begun to further specify the set of executive control abilities that tend to be enhanced for bilingual individuals. There is a dearth of research regarding individuals who have acquired bilingualism later in their childhood, but one study has initiated movement in that direction. Carlson and Meltzoff (2008) administered nine executive functioning measures to a large number of kindergarten children from 3 language groups: native bilinguals (English-Spanish), monolinguals (English), and English speakers enrolled in a Spanish as a second-language immersion kindergarten. They examined demographic factors of groups and found that the native bilinguals had significantly lower verbal scores, less advanced parent education, and lower income levels compared to the two other groups. Nevertheless, the bilingual children's raw scores on the executive functioning tasks did not differ from their peers, and after the researchers statistically controlled for lower verbal scores and parent education and income levels, the researchers found that the native bilingual children performed significantly *better* on the executive functioning battery than the other two groups. The authors used the phrase "doing more with less" (Carlson & Meltzoff, 2008, p. 292) to describe the findings that the native bilingual group did not differ from the other groups on the executive functioning measures despite their lower parental education levels and verbal abilities. Notably, the English speakers in the Spanish as a second-language immersion kindergarten in the study had only been in the immersion program for 6 months when tested. Also, this study found that although groups did not differ in the ability to suppress a motor response or delay of gratification tasks, the bilingual

advantage existed in executive functioning measures that purport to require attention control and inhibition to a districting response, which are sometimes referred to as *conflict tasks* (Carlson & Meltzoff, 2008).

Research has demonstrated the bilingual advantage in young children in addition to older adults. In a study that compared 93 bilingual and 91 monolingual older adults who had been diagnosed with dementia, it was found that age of onset of dementia symptoms was four years later for bilingual adults compared to the monolingual adults in the study when all else was equal (Bialystok, et al., 2007). These findings suggest that the demand of managing and switching between two languages regularly may keep the brain active, thus preventing against cognitive decline.

Neuropsychological Support for Bilingual Advantage

In the last decade, research has begun to explore the neuropsychological basis for the bilingual advantage in executive control (Price, Green, & von Studnitz, 1999; Fabbro, Skrap, & Aglioti, 2000; Kovacs & Mehler, 2009). Kovacs & Mehler (2009) conducted three eye-tracking studies in which they showed that 7-month-old bilingual[3] infants, who were exposed to 2 languages from birth, showed improved cognitive control abilities compared with matched monolingual infants. In the first part of the eye-tracking task, both monolingual and bilingual infants were able to learn to respond to a speech or visual

[3] Though infants were not verbal at this stage, "bilingual" refers to the fact that they were exposed to two languages from birth.

cue to anticipate a reward on one side of the screen by looking to that side. In the second part of the task, only the bilingual infants succeeded in learning to redirect their looks when the cue began signaling the reward on the opposite side. The bilingual infants showed advanced ability compared to monolingual infants in their ability to suppress a response (stop looking to first location) and learn a new response (look at new location). These findings provide early developmental support for enhanced attention and cognitive control abilities in bilingual children. It is particularly interesting that this study showed the bilingual advantage in infants, who had obviously not yet learned to speak. This provides further evidence that enhanced executive control abilities for bilinguals may be domain-general and not tied to tasks involving linguistic abilities.

Another study used Positron emission tomography (PET) imaging to scan 6 subjects whose L1 was German and L2 was English, and whose L2 was acquired around the of age 9 (Price, Green, & von Studnitz, 1999). Subjects' brains were scanned while they read or translated a list of words that were presented visually, one at a time in either their L1, L2, or switching between L1 and L2. The researchers found that translating, in contrast to reading, mainly activated the regions of the brain used in the coordination of mental operations. These regions were found to be the anterior cingulate, putamen, and caudate nucleus. Language switching activated similar areas as translation, though they activated different language areas. Translation was associated with language regions involved in articulation, while switching was associated with regions involved in phonology. These findings suggest that the bilingual brain uses executive control and

mental coordination regions of the brain in managing two languages. Even if you are fluent in both English and *Spanish*, it is difficult to switch back and forth in the languages, as in: "one, *dos*, three, *cuatro*, five, *seis*". One uses a high amount of mental effort and cognitive control in switching between languages.

The study of unique deficits found in bilingual individuals who have suffered head trauma has also shed light on the brain mechanisms involved in bilingualism. Fabbro, et al. (2000) reported a case study of a bilingual patient with brain damage who demonstrated no deficits to either of his languages (L1 = Friulian, L2 = Italian), but who showed a behavior called pathological switching. In pathological switching, the patient randomly alternates their use of either language across different utterances. Despite their cognitive awareness that the context is less appropriate for one of their languages, they are unable to control their language switching. The most fascinating piece of the case study as it relates to the uniqueness of the bilingual brain is that the patient showed a complete lack of aphasic symptoms, or no deficiencies in either language, despite the switching impairment (Fabbro, et al., 2000). This suggests that the system responsible for switching between languages is independent of language. It appears that the frontal lobe regulates switching between different languages in bilingual subjects in a similar fashion to how they regulate switching between tasks in non-language domains.

Cross-Language Interference Framework

It has been posited that a cross-language interference framework, in which verbal and executive control processes are understood to be independent, may help to explain the bilingual disadvantage in vocabulary size and verbal fluency, and the bilingual advantage in executive control (Bialystok et al., 2008a). According to the cross-language interference framework, the conflict and demand of activating representations of two different languages for bilingual individuals is resolved through enhanced executive control for this population. Research demonstrating the existence of the purported advantages and disadvantages of bilingualism within the same bilinguals individuals provides support for the framework because these studies show how the attention and cognitive control demanded in using two languages may help ameliorate the linguistic demands faced by these same individuals (Bialystok et al., 2008a; Bialystok et al., 2008b; Bialystok & Craik, 2010; Sandoval et al., 2010). Studies that have provided some neuropsychological evidence of the separateness of the mechanisms used in executive control and language abilities support the possibility that one system may be enhanced, while the other may be somewhat compromised in bilingual individuals (Price et al., 1999); Fabbro, et al., 2000; Kovacs & Mehler, 2009).

Importantly, the differences in cognitive abilities for bilinguals and monolinguals cannot be exclusively attributed to the cross-language framework. As the literature has shown consistently, it is essential not to ignore the effects that ethnicity, culture, socio-economic status, and parental education levels can have on the cognitive abilities of different groups (e.g., Christian & Bloome, 2004; Vygotsky, 1962). Language is

inherently not neutral, but rather is inextricably linked to identity and culture. Brain imaging studies allow for the understanding of language use in a more objective manner, but many other studies cited in the proposed study examine language as enmeshed in socio-cultural milieu (e.g., Carlton & Meltzoff, 2008).

Integration of Theories and Summary

The proposed study will draw upon the cross-language framework of the bilingual advantage and disadvantage (Bialystok, 2008a), the critical period of second language acquisition framework (Mayberry & Lock, 2003), and the distributed characteristic and exposure frameworks of bilingual vocabulary knowledge (Branum, et al., 2009; Oller & Eilers, 2002a, 2002b) to inform hypotheses about possible differences across student groups in executive control, verbal fluency, and vocabulary size. The aim of the study is to examine possible differences across student groups on these three cognitive abilities and to make inferences about how different experiences with language use and exposure could be affecting performance. The proposed study expands previous research by including a student group that becomes bilingual later in life, and this study considers the effects of different educational settings, specifically the 50-50 two-way dual language immersion classroom compared to the monolingual general education classroom, on executive control, verbal fluency, and vocabulary size of the student groups.

It is hypothesized that the executive control advantage will be found in the native and late bilingual groups, as both groups will be proficient in each language and will have

experience switching between two languages regularly, and because both groups will have been exposed to some language during early childhood. It is hypothesized that student groups will demonstrate differential performance on verbal fluency measures due to factors including cross-language interference, and English verbal abilities. It is expected that no significant differences in English vocabulary size will be found for the late bilingual and monolingual groups because these student groups will have been exposed to English outside of school for the vast majority of the time, and both groups will have been exposed to only English for the first 5 years of their life. The native bilingual group is expected to show lower English vocabulary size than the other two groups due to their less frequent exposure to English throughout their life. However, the native bilingual group is expected to show a significantly larger Spanish vocabulary compared to the other student groups.

Chapter Three: Proposed Research Study

Statement of the Problem and the Purpose

In the past decade, research has presented advantages and disadvantages to being proficient in and switching between two languages. While research maintains that bilingual children tend to show smaller vocabularies in both language and are less efficient at accessing words than monolingual children (Gollan et al., 2002; Oller, et al., 2007; Sandoval, et al., 2010), studies have also uncovered evidence of advantages in executive control for children who are exposed to two languages early in their development. The strengths in executive functioning tasks for bilingual children have been found to include increased abilities compared to monolingual children on tasks requiring inhibition to preponent or distracting responses, and tasks that require attention shifting and control (Bialystok, 1999; Carlson & Meltzoff, 2008; Gollan, et al., 2002; Bialystok, Craik, & Luk, 2008a, 2008b; Bialystok & Craik, 2010).

While these findings have been replicated and are gaining widespread acceptance, the exploration of cognitive differences in bilingual and monolingual children is still in its early stages and many questions remain unanswered. Research has shown that native bilinguals have stronger skills on executive control, but studies have yet to find similar enhanced abilities in children who acquire a second later in life, such as through participation in dual-language immersion programs. Understanding how bilingualism affects children's cognitive abilities, and comparing these effects between native and late bilinguals, has implications for educational policies and assessment procedures. The

proposed study seeks to investigate the differences in executive control, verbal fluency, and vocabulary size for native and late bilinguals and monolinguals to highlight possible discrepancies in cognitive abilities due to diverse experiences with language.

Research Questions and Hypotheses

Research Question 1

Will significant differences be found between the English and Spanish vocabulary knowledge of the native bilingual, late bilingual, and monolingual groups?

Hypotheses 1a, 1b. It is hypothesized that the late bilingual and monolingual groups will show significantly higher English vocabulary knowledge than the native bilingual group (1a). It is expected that the native bilingual group will show significantly higher Spanish vocabulary knowledge than the late bilingual group (1b). The monolingual group will not be assessed on Spanish vocabulary knowledge.

Rationale. Research suggests that bilinguals tend to show lower vocabulary knowledge in either or both of their languages because they are exposed to their two languages in different amounts and under different circumstances (Branum, et al., 2009; Oller & Eilers, 2002a, 2002b; Oller et al., 2007; Verhoeven, 1994, 2000). The distributed characteristic of bilingual vocabulary knowledge purports that bilinguals' experience with words in each language is unevenly distributed, leading to knowledge of both language translation of some words, but not others. Because the monolingual and late bilingual groups will have exposure to English in home and school, however, and will know English words in the home and school contexts, they are expected to demonstrate

significantly greater English vocabulary knowledge compared to the native bilingual group. The native bilingual group is expected to have significantly greater Spanish vocabulary knowledge than the other groups due to being exposed to Spanish words in their home and school contexts. The native and late bilingual groups will show significantly more knowledge in English and Spanish vocabulary knowledge combined because the monolingual group will lack proficiency in Spanish.

Research Question 2

Will significant differences be found for total number of words correctly provided (minus errors) for the verbal fluency tasks, on the category and letter fluency measures, for the native bilingual, late bilingual, and monolingual groups?

Hypothesis 2a, b. It is hypothesized that the monolingual control group will provide significantly more correct words than the native and late bilingual groups on the category fluency task, and that the late bilingual group will provide significantly more correct words than the native bilingual group on the category fluency task (2a). It is hypothesized that the late bilingual group will provide significantly more correct words on the letter fluency task than the native bilingual group and monolingual groups (2b).

Rationale. Research suggests that bilinguals are less efficient than monolinguals on category fluency tasks due to cross-language interference experienced by bilinguals when activating two competing representations of words (e.g., for dog, "dog" and "perro" are represented) (Gollan et al., 2002; Bialystok, et a., 2008a; Bialystok & Craik, 2010; Sandoval, et al., 2010). Research also suggests that performance on the category fluency

task is affected by vocabulary size (Baron, 2004). Therefore, the monolingual group is expected to outperform both groups because of lack of cross-language interference, and the late bilingual group is expected to outperform the native bilingual group due to increased vocabulary size. Research has demonstrated that the letter fluency task taps into both lexical access and executive control abilities, especially controlled attention and inhibition of preponent responses (Baron, 2004) and bilinguals have been shown to perform significantly better than monolinguals on this task when vocabulary is controlled on these tasks (Bialystok, et al., 2008b; Luo, Luk, & Bialystok, 2010). Because it is expected that the late bilingual group will have similar English vocabulary knowledge compared to the monolingual group and enhanced executive control abilities compared to the monolingual group, the late bilingual group is expected to outperform both groups on the letter fluency task.

Research Question 3

Will significant differences be found among the native, late bilingual, and monolingual groups in number of Total Errors (TE) and Perseverative Errors (PE) made on the WCST-64, demonstrating differences in executive control? Of greatest interest, will the late bilingual group outperform the monolingual group on this executive control measure compared to the monolingual group despite having acquired their second language later in life?

Hypothesis 3. It is hypothesized that the native and late bilingual groups will show significantly lower TE and PE scores as measured by the WCST-64 compared to the

monolingual group, thus demonstrating superior executive control abilities compared to monolinguals.

Rationale. Research has demonstrated that proficiency in two or more languages, and frequent use of and switching between the languages, contributes to enhanced executive control (Bialystok, 1999; Carlson & Meltzoff, 2008; Bialystok, et al., 2007). Research has also suggested that acquisition of a second language is dependent on exposure to some (any) language early in life, but that proficiency in the second language is not restricted by age of second language acquisition (Mayberry & Lock, 2002). Neurological research has shown that level of attained proficiency in a second language, rather than the age of acquisition, is the determinant of the cortical representation of the second language (Perani, et al., 1998). Taken together, it is expected that native and late bilinguals will show enhanced executive control compared to monolinguals because both groups will have proficiency in and frequent use of and switching between English and Spanish.

Methods

Overview.

The study compares vocabulary knowledge, verbal fluency, and executive control across the following groups: a) students who are native bilinguals that have completed at least 5 years of a 50-50 dual language immersion program in English-Spanish in school, b) students who are late bilinguals that have completed at least 5 years of a 50-50 dual

language immersion program in English-Spanish in school, and c) students who are monolinguals that have not had second language instruction.

Participants.

Participants will include 225 children in the 6th grade from 4 middle schools within the same urban public school district (mean age = 12 years, range = 11-13 years). Participants will include 110 females and 115 males. All participants will have begun their formal education in the U.S. by the age of 6. As part of the selection procedure, parents of participants will have completed a Language and Education Survey assessing languages spoken at home by the parent and child.

Participants will only be included if they are in the average range of verbal cognitive ability and working memory ability for their age and have comparable English and Spanish language proficiency, as assessed by The *Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4)* (Dunn & Dunn, 2007), the *Test de Vocabulario en Imàgenes Peabody – Adaptaciòn Hisponoamericana (TVIP)* (Dunn, Padilla, Lugo, & Dunn, 1986), and the Spatial Span Subtest of the *Wechsler Memory Scale-III (WMS-III)* (Wechsler, 1997) (see Instrumentation section). Children with any reported learning disabilities or any children who are enrolled in special education services will not be included in the study.

The *Native Bilingual (NB)* group will consist of 75 students who had exposure from birth to Spanish and English. For this group, parents report speaking Spanish and English in the home. Either both parents are native Spanish speakers, who speak Spanish

and English at home, or one parent speaks Spanish and the other speaks English. These students will have completed a 50-50 English-Spanish dual-language immersion program from Kindergarten through 5th grade. The dual-language program involves about half of classroom instruction in English and half in Spanish throughout the school day. In the programs, language instruction alternates from morning to afternoon, and after a designated amount of time, the morning and afternoon languages are switched. All participants will have been enrolled in general education classes in English-only after 5th grade. All students in the NB group will use both English and Spanish daily at home, in addition to school.

The *Late Bilingual (LB)* group will consist of 75 students who are native monolinguals in English and were exposed to only English from birth through age 5. These students gained exposure in Spanish (at least 10 hours per week) beginning between the ages of 4-6 (mean age = 5) in Kindergarten for a duration of 6 years. For this group, parents are native English speakers who speak English at home. As with the NB group, these students will have completed a 50-50 English-Spanish dual-language immersion program in Kindergarten through 5th grade. All participants will have been enrolled in general education classes in English-only after 5th grade.

The *Monolingual Control (MC)* group will consist of 75 students who are native monolinguals in English, and have not had significant exposure to a second language, which is defined as no more than 2 hours per week of exposure to a non-English language. For this group, parents will be native English speakers who speak English at

home. These students will have been enrolled in general education instruction in English without supplementary language instruction in elementary or middle school.

Instrumentation.

Language and Education Survey. Parents of participants, and participants, will complete a Language and Education survey, adapted from the Houston Independent School District (HISD) Home Language Survey (HISD, 2010).

English and Spanish Vocabulary Knowledge. The *Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4)* will be administered as a standardized test of receptive vocabulary in English (Dunn & Dunn, 2007) and the *Test de Vocabulario en Imàgenes Peabody – Adaptaciòn Hisponoamericana (TVIP)* (Dunn, et al., 1986) will be administered as the current Spanish version of the PPVT-4. It should be noted that the TVIP contains the same format as the PPVT-4, but not the same items. On these tests, participants are shown a card containing four pictures, and the experimenter names one of the images. Participants are asked to indicate, verbally or by pointing, which image depicts the word given by the experimenter. The cards are organized in order of increasing difficulty, and after a basal score is established, testing is continued until the participant makes six errors in eight consecutive responses. Raw scores will be converted to standard scores based on the age of the participant.

For standardization of the PPVT-4, more than 5,500 individuals were tested, with data from 4,000 of them used for the normative scores. The norm sample matches the current U.S. population along parameters of sex, race/ethnicity, geographic region,

socioeconomic status (SES), and clinical diagnosis or special education placement (Dunn & Dunn, 2007). The split-half reliability coefficients averaged .94 or .95 on each form of the PPVT-4. The coefficient for the alternate-form reliability averaged .89 with all of the coefficients falling between .87 and .93 for each respective form. The test-retest coefficient was .93 with a range of .92 to .96 (Dunn & Dunn, 2007). When compared to the *Expressive Vocabulary Test*, Second Edition (EVT-2), there was a mean correlation of .82. When comparing the PPVT-4 with the *Comprehensive Assessment of Spoken Language* (CASL) and the *Clinical Evaluation of Language Fundamentals*, Fourth Edition (CELF-4), the correlations ranged from the mid-.60s to high .70s.

Based on the PPVT-R (Dunn & Dunn, 1981), the TVIP contains 125 translated items to assess the vocabulary of Spanish-speaking and bilingual students. Items were carefully selected through rigorous item analysis for their universality and appropriateness to Spanish-speaking communities (Dunn, et al., 1986). For internal consistency reliability, the median correlation coefficient, corrected using the Spearman-Brown formula, was .93. For concurrent validity, correlations ranged from .25 to .59 between scores on the TVIP and the *Kaufmann-ABC Global Scales* and from .28 to .69 between the TVIP and the Kaufman-ABC Achievement Scale Subtests. The correlation between TVIP and the *Habilidad General Ability* test was .44 among children attending an urban private school in Puerto Rico (Dunn, et al., 1986).

In addition to ascertaining receptive vocabulary for participants, the PPVT-4 and TVIP tests will also establish that all participants are functioning at a normal level of cognitive verbal ability for their age in each language.

Verbal fluency. The *Category (animal) and Letter (FAS) Fluency tasks*, taken from the D-KEFS battery (Delis, Kramer, & Kaplan, 2001), will be administered to assess semantic knowledge and retrieval abilities of participants. For the letter fluency subtest, participants are instructed to verbally list as many words as they can that start with the given letter (F, A, or S) within a minute for each letter/trial. Participants are instructed to exclude names of people, places, numbers, and verbs with different endings (i.e., if participant says "run", then "ran" would not be allowed). The experimenter will time the task with a stopwatch and record all words that produced by writing them down and audiotaping for later verification in scoring. The same standardized procedures are used for the category fluency task, except there is only one trial and the participant is asked to verbally list the names of as many animals as they can within a minute. Repetition errors and set-loss errors, in which participants provide an answer that does not fit criteria for the task, are subtracted from the total score in each letter or category condition to obtain a raw score. For letter fluency, the raw scores are the average of correct responses across the three letters.

Early normative data for children aged 6 to 13 were published for the FAS and category tests, and retest reliability ranges from .67 to .88, and .64 to .87, respectively (Baron, 2004). Word retrieval data for the Animals category was reported in a normative

study on 6- to 13-year-old Canadian children by four grade levels (Baron, 2004). Studies show interrater reliability in scoring to be high, with correlations across raters at .991 and .999 for scoring monolinguals and bilinguals, respectively, in letter fluency, and .997 and .995 for scoring monolinguals and bilinguals in category fluency (Gollan, et al., 2002).

Working Memory. The *Spatial Span Subtest in Wechsler Memory Scale-III (WMS-III)* will be administered to participants to assess memory span (forward) and working memory (backward) abilities, and to provide an additional non-verbal cognitive measure to equate participants. For this subtest, a random array of blocks on a base contain a number from 1 to 10 on the back, and the numbers are visible only to the experimenter, not the participant. In the forward condition, the experimenter taps a sequence of blocks, and participants are instructed to repeat the sequence in the same order. The sequence begins with two blocks and increases by one block every second trial, so there are two trials for each sequence length, and testing continues until participants fail to correctly replicate both trials at a specific sequence length. In the backwards condition, participants are instructed to repeat the sequence demonstrated by the experimenter in reverse order, and all other procedures are the same as the forward condition. Both conditions begin with practice trials, and the order of presentation of forward and backward conditions will be counterbalanced across participants. The score is the longest sequence length that could be correctly recalled in each condition. This test has shown moderate to high correlation (.60 to -82) with the Wechsler auditory/verbal digit span

test, and has been found to be sensitive to short-term memory deficits in a study of Williams syndrome patients (Barton, 2004).

Executive Control. The *Wisconsin Card Sorting Test* (WCST-64) (Heaton, 1981; 2000) will be administered to participants as a measure of cognitive flexibility, set shifting, the ability to inhibit preponent responses, and controlled attention (Baron, 2004). For the standard administration of the WCST-64, four stimulus cards are placed in front of the participant, and a set of 64 response cards become the participant's deck. The participant must match each consecutive response card to the examiner's stimulus cards according to the principle they devise (i.e., color, form, or number), and the participant is told if he or she is right or wrong for each response without being told the active principle. The participant is unaware that the sorting principle is changed at a designated time and that he or she must adjust the sorting accordingly. The criterion is six complete correct sorts or termination when all 64 cards are attempted.

Studies have reported a consistent three-factor structure across a number of populations for scores on the WCST-64. The scores recorded and examined for the purposes of this study will be the Total Number of Errors (TE) and Perseverative Errors (PE). These scores have been shown to load highly on Factor I, one of three factors identified as making up the WCST-64 (Heaton, 2000; Greve, 2001). The scores that load most highly on Factor 1 reflect aspects of executive functioning, primarily cognitive flexibility, while Factor II has been suggested to reflect ineffective hypothesis testing strategy in the absence of perseveration, and Factor III has been shown to reflect ability

to maintain correct responding once the correct set is determined[4] (Greve, 2001; Heaton, 2000). The shorter WCST-64 has been recommended for children as it involves a less-prolonged administration with less time for the participant to experience the complex nature of the task or become frustrated (Baron, 2004). Normative data for the WCST-64 are available for those 6.5 to 85 years old, with age-corrected norms given for children below age 20 (Baron, 2004). The WCST-64 has consistently demonstrated construct validity in differentiating between healthy patients and those with executive function impairment, primarily in stroke patients (Baron, 2004).

Procedure.

Recruitment and Assessment. Students comprising the NB, LB, and MC groups will be recruited from 6th grade general education language arts classrooms in four middle schools in a large urban, public school district. The researcher will contact language arts teachers with consent from the school district through University of Texas. Language arts teachers will be asked to send the Language and Education survey and Parental Consent Form home with their 6th grade students for parents to complete. After teachers collect completed surveys and consent forms, two graduate research assistants (GRAs) unaffiliated with the research study identify all surveys that fit into one of the

[4] Another reason to choose these scores (TE and PE) is because age-corrected standard scores, t-scores, and percentile rankings are provided for children and adolescents under 20 years of age for these scores. The Non-perseverative Response (NPR) and Conceptual Level Response (CLR) scores are the only other scores on the WSCT-64 with normative data in the form of standard scores, and these load on moderately on Factor II, which is of less interest for the purposes of the current study.

three groups in the study: NB, LB, and MC. Surveys not fitting into any group will be shredded. The GRAs will place all appropriate surveys in three piles for NB, LB, and MC, in alphabetical order by last name. For each survey obtained, GRAs will contact parents by telephone to verify information in the survey and discuss their child's participation in the study. The researcher will verify through cross-checking with school records and Language and Education surveys that each NB and LB student selected for the study has participated in the 50-50 dual-language immersion program in Spanish-English from K through 5th grade, as indicated, and each MC student had been enrolled in general education with English instruction from K-5th grade.

Six doctoral students in School Psychology from the University of X will administer the battery of tests. Four students who are fluent in Spanish and English will administer the Spanish vocabulary test, and these tests will be counterbalanced across NB and LB participants. The six doctoral students will be randomly assigned to administer the remaining measures in the battery, including English vocabulary tests, verbal fluency, working memory, and executive control tests over a two-month period for each of the 225 students identified as NB, LB, or MC. Participants will complete the battery in one after-school session, and it is estimated that each session will last 1 to 1.5 hours.

Data Analyses and Expected Results

The primary purpose of this study is to examine how the performance of native bilinguals, late bilinguals, and monolinguals compared on measures of vocabulary knowledge in English and Spanish, verbal fluency, and executive control. Possible

differences across groups in working memory and years of maternal education will be examined as part of preliminary analyses. Students not falling within the normal range of intelligence as measured by the PPVT-4 will not be included in the study.

To control for inflated Type I error rates across multiple outcomes variables, research has suggested separate F tests on each outcome variable with a Bonferroni-based correction applied across outcome variables (Jaccard & Guilamo-Ramos, 2002). Due to the high number of comparisons for this study, Multivariate Analysis of Variance (MANOVA) will be used for two outcome variables, verbal fluency and executive control, because each of these variables contains two separate scores and these scores are measuring the same contruct. By using MANOVA for these two comparisons, rather than ANOVA, the per comparison alpha level of 0.05 needs only to be divided by four (for four comparisons in total) rather than by six, which would likely inflate Type II error. Thus, two ANOVAs and two MANOVAs will be used in the current study, and an adjusted alpha level of .0125 (0.05/4) will be used for each comparison to protect against Type I error.

Preliminary Analyses.

Prior to testing research hypotheses, descriptive statistics and frequencies will be calculated and examined, including means, standard deviations, ranges, and minimum and maximum values. To ensure that no assumptions of MANOVA and ANOVA have been violated, tests of normal distribution, homogeneity of variance, and independence between groups will be conducted. The distributions of the dependent variable for each

group will be examined to ensure that the dependent variable is normally distributed for the population. Levene's Test of Equality of Variances will be conducted to ensure that the population variance for each group is equal. For the two MANOVA and ANOVAs, a power analysis using the G*Power program calculated a required sample size of 219 with the adjusted alpha level of 0.0125 for 4 comparisons. A final sample size of 225, with 75 per group, was selected to ensure a sufficient level of power for all statistical analyses.

As part of the preliminary analyses, I will conduct an ANOVA across the 3 groups to compare the groups' scores on the WMS-III to examine possible differences in working memory abilities. For this analysis I will use an unadjusted alpha level of 0.05 because this is an exploratory analyses and I will not be making inferences based on this data. It is hypothesized that no significant differences across groups in working memory will be found. I will conduct a chi-square analysis to determine if differences in observed compared to expected frequencies across categories of maternal education across groups are greater than would be expected by sampling error. It is hypothesized that the chi-square analysis will show that observed differences in maternal education across groups are not greater than is expected due to sampling error.

Hypothesis 1a. It is hypothesized that the late bilingual and monolingual groups will show significantly higher English vocabulary knowledge than the native bilingual group.

To compare the groups on English vocabulary knowledge, a one-way ANOVA with one factor (total score on PPVT-4) and three levels/groups (native bilingual, late

bilingual, and monolingual) will be run to determine whether there is a significant difference between the means of the three groups. The *F* test p-value is predicted to be less than .0125, suggesting significant difference among the means of the English vocabulary scores between groups. Post hoc tests will be conducted to determine the source of the significant *F*. Results of Tukey's HSD procedure will adjust the p-value to examine if the differences between groups are statistically significant. It is predicted that the late bilingual and monolingual groups will show significantly higher English vocabulary scores than the native bilingual group.

Hypothesis 1b. It is expected that the native bilingual group will show significantly higher Spanish vocabulary knowledge than the late bilingual group. The monolingual group will not be assessed on Spanish vocabulary knowledge.

To compare the group differences on Spanish vocabulary knowledge, a one-way ANOVA with one factor (Spanish vocabulary score on TVIP) and two levels/groups (native and late bilingual) will be run to determine whether there is a significant difference between the means of the two groups.

The *F* test p-value is predicted to be less than .0125, suggesting significant difference among the means of the Spanish vocabulary scores across groups. Post hoc tests will be conducted to determine the source of the significant *F*. Results of Tukey's HSD procedure will adjust the p-value to examine if the differences between groups are statistically significant. It is predicted that the native bilingual group will show significantly higher Spanish vocabulary knowledge than the late bilingual group.

Hypothesis 2a, b. It is hypothesized that the monolingual group will significantly outperform the native and late bilingual groups on the category fluency task, and the late bilingual group will significantly outperform the native bilingual group on the category fluency task (2a).

It is hypothesized that the late bilingual group will significantly outperform the native bilingual and monolingual groups on the letter fluency task (2b).

To test the hypotheses 2a and b, a MANOVA will be conducted to examine performance differences between the three groups on the two scores of verbal fluency, category and letter. The independent variable is student group (native, late bilingual, and monolingual), while the dependent variables are scores on the category and letter fluency tasks. The MANOVA test will determine if groups have different population means on the two verbal fluency measures, considered simultaneously. As there is a multi-level nominal independent variable (native bilingual, late bilingual, and monolingual groups), and two dependent variables (category and letter score), the specific type of multivariate analysis that will be utilized is the *Wilks' lambda, U*. It is expected that the main effect of group membership will be statistically significant at $p < .0125$, suggesting that a significant difference in performance likely exists between groups on at least one of the verbal fluency tests. Subsequent individual t-tests will reveal on which tests significant performance differences exist. It is predicted that the monolingual group will provide more correct words than the native and late bilingual groups, and the late bilingual group will provide more correct words than the native bilingual group on the category fluency

task. It is predicted that the late bilingual group will provide more correct words on the letter fluency task than the native bilingual and monolingual groups.

Hypothesis 3a, b. It is hypothesized that the native and late bilingual groups will demonstrate enhanced executive control abilities as shown by making significantly fewer Total Errors (TE) (3a) and Perseverative Errors (PE) (3b) on the WCST-64 as compared to the monolingual group.

To test hypotheses 3a and 3b, a MANOVA will be conducted to examine differences between the three groups on the two scores of the WCST-64 (TE and PE scores). The independent variable is student group (native, late bilingual, and monolingual), while the dependent variables are TE and PE scores. The MANOVA test will determine if the groups have different population means on the two scores, considered simultaneously. As there is a multi-level nominal independent variable (native bilingual, late bilingual, and monolingual groups), and two dependent variables (TE and PE scores), the specific type of multivariate analysis that will be utilized is the *Wilks' lambda, U*. It is expected that the main effect of group membership will be statistically significant at $p < .0125$, suggesting that a significant difference in performance likely exists between groups in test performance on at least one outcome score. Subsequent individual t-tests will reveal on which subtests significant performance differences exist. It is predicted that the native and late bilingual groups will make significantly fewer errors, as show by significantly lower TE and PE scores compared to the monolingual group.

Chapter Four: Summary and Implications

Summary

Promoting bilingualism in children by supporting the acquisition and maintenance of more than on language in U.S. public schools has been a controversial issue for centuries (Blanton, 2004). A better understanding about unique cognitive abilities of bilinguals and monolinguals may provide more objective support for bilingual education programs. The proposed study seeks to extend research on differences in vocabulary size, verbal fluency, and executive control across three groups of students with diverse experiences with language. The three groups include English monolingual students, native bilingual students who have been exposed to English and Spanish since birth, and late bilingual students who began to be exposed to Spanish, in addition to their native English, at the age of 5 or 6 in school. The native and late bilingual groups will have participated in a 50-50 dual language immersion from Kindergarten through 5th grade, involving daily switching between English and Spanish in the classroom. The native bilingual group will have been exposed to English and Spanish in the home, while the late bilingual and monolingual groups will have been exposed to only English in the home. The three groups will be compared on measures assessing vocabulary, verbal fluency, and executive control. Research in the past decade has begun to shed light on cognitive differences between bilinguals and monolinguals (e.g., Bialystok, et al., 1999), but there is a dearth of research examining cognitive abilities for individuals who emerge as bilinguals later in life.

Projected findings will be summarized for vocabulary, verbal fluency, and executive control. Late bilinguals and monolinguals are predicted to show comparable English vocabulary knowledge because these groups will have been exposed to English outside of school for the vast majority of the time, and both groups will have been exposed to only English for the first 4 or 5 years of their life. The native bilingual group is predicted to show lower English vocabulary knowledge, comparatively, due to their less frequent exposure to English. Native bilinguals are expected to show greater Spanish vocabulary knowledge than late bilinguals due to increased exposure time to Spanish in the home since birth. Previous research has suggested that bilinguals show lower vocabulary than monolinguals due to the distributed characteristic of bilingual vocabulary knowledge, which presumes that bilinguals' experience with words in each language is unevenly distributed across contexts (Branum, et al., 2009; Oller & Eilers, 2002a, 2002b). Late bilinguals are predicted to outperform native bilinguals in English vocabulary size, and native bilinguals are predicted to outperform late bilinguals in Spanish vocabulary size because each group has differential exposure to and experience with each language.

Monolinguals are predicted to outperform both bilingual groups on category fluency, and late bilinguals are predicted to outperform native bilinguals on category fluency. Previous research supports a cross-language interference framework that suggests bilinguals are weaker than monolinguals in category fluency because they need to activate two representations of a word and to choose one (e.g., "dog" or "perro") (Bialystok, 2008a; Luo, et al., 2009; Sandoval, et al., 2010). Late bilinguals are predicted

to outperform native bilinguals and monolinguals on letter fluency. Studies suggest that cross-language interference is lessened in letter compared to category tasks, and that enhanced executive control due to managing two languages tends to enhance bilingual performance in letter fluency tasks (Bialystok, et al., 2008b; Luo, et al. 2009). Lower English vocabulary for the native bilinguals is expected to lower their performance on the verbal fluency tasks, which are administered in English, compared to late bilinguals.

Native and late bilinguals are predicted to outperform monolinguals in tasks of cognitive flexibility and executive control. Numerous studies show an advantage for bilinguals compared to monolinguals on executive control tasks (e.g., Bialystok, 1999, Carlson & Melt off, 2008). It is argued that enhanced executive control in bilinguals is the result of their increased demand compared to monolinguals to switch between two languages, and to inhibit one language depending on the context. The critical period of second language acquisition framework (Mayberry & Lock, 2003) suggests that exposure to any language at birth is the critical component in acquiring proficiency a second language later in life. As both bilingual groups will have had frequent practice with and use of two languages for several years, it is predicted that they will both show enhanced executive control abilities compared to monolinguals.

Implications

If the projected results of the proposed study are found to be significant, there will be implications for the assessment of bilingual students. These findings suggest a need to norm neuro-psychological and psycho-educational tests on bilingual samples due to

possible effects of managing two languages on performance across measures of vocabulary, verbal fluency, and executive control. In school assessments, the negative effects of cross-language interference on efficiency of test taking for bilinguals should be examined. Additionally, the discrepancy in language exposure for bilinguals who speak Spanish only or English and Spanish in the home suggests that supplementary English vocabulary instruction in the classroom, including common school *and* home vocabulary, may be beneficial for these bilinguals. Another implication for instruction is that supporting and honing bilinguals' enhanced executive control abilities may bolster their abilities in other cognitive domains. The projected findings of the study highlight how the task of managing two languages may impact cognitive abilities even when a student demonstrates proficiency in both languages. Notably, while projected findings suggest that monolinguals may show greater vocabulary size than bilinguals in a single language due to more frequent exposure to that language at home and school, the *total* size of native and late bilinguals' vocabulary in *both* languages will arguably be greater than monolinguals' vocabulary. From a broader perspective, the study brings up questions about educational objectives of schools in the 21st century. For example, if monolinguals have an English-only vocabulary advantage, does that outweigh a disadvantage in executive control? Does proficiency in two languages outweigh decreased vocabulary knowledge in a single language for bilinguals?

Limitations

Projected findings of the study are constrained by assumptions about the groups involved, and their school, home, and community environments. The study differentiated student groups by language experience, and it was beyond the scope of the study to examine how important factors such as race, ethnicity, and culture might impact performance on the measures used, especially as a distinguishing factor between native and late bilinguals. It was assumed that home environments for each language group involved equivalent amounts of educational enrichment and parental support, and that the dual-language and the general education classrooms from which participants were recruited did not differ substantially in the quality of education provided. The researcher aimed to control for differences in classroom instruction quality by recruiting student from the same urban school district from schools with equitable resources. In terms of participant recruitment, it could be argued that parents who returned completed Language and Education surveys and consent for their children's participation in the study were not a representative sample. Finally, it could also be argued that parents who choose to enroll their monolingual English children in dual-language programs in school differ qualitatively from parents who do not elect to enroll their monolingual children in these programs. It was beyond the scope of the study to examine how these possible parental differences in worldview or values would be reflected in cognitive ability outcomes for their children.

Future Research

The effect of bilingualism on cognitive abilities is a new area of study in psychological research, and there are many avenues for future research. It would be interesting to analyze how cognitive abilities relate to or predict one another in general across bilingual and monolinguals, or differentially among the groups. For example, does executive control affect bilinguals' performance in verbal fluency to a different extent than for monolinguals with matched English vocabulary? Additionally, more measures should be used with language groups to further specify subtle differences in cognitive abilities among groups. On measures with multiple score outputs, such as the Wisconsin Card Sorting Test, research should examine how bilingual and monolingual performance may differ on specific components of the tests but not on others. Finally, neuropsychologists should continue to explore brain differences between native and late bilinguals and monolinguals through fMRI studies.

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